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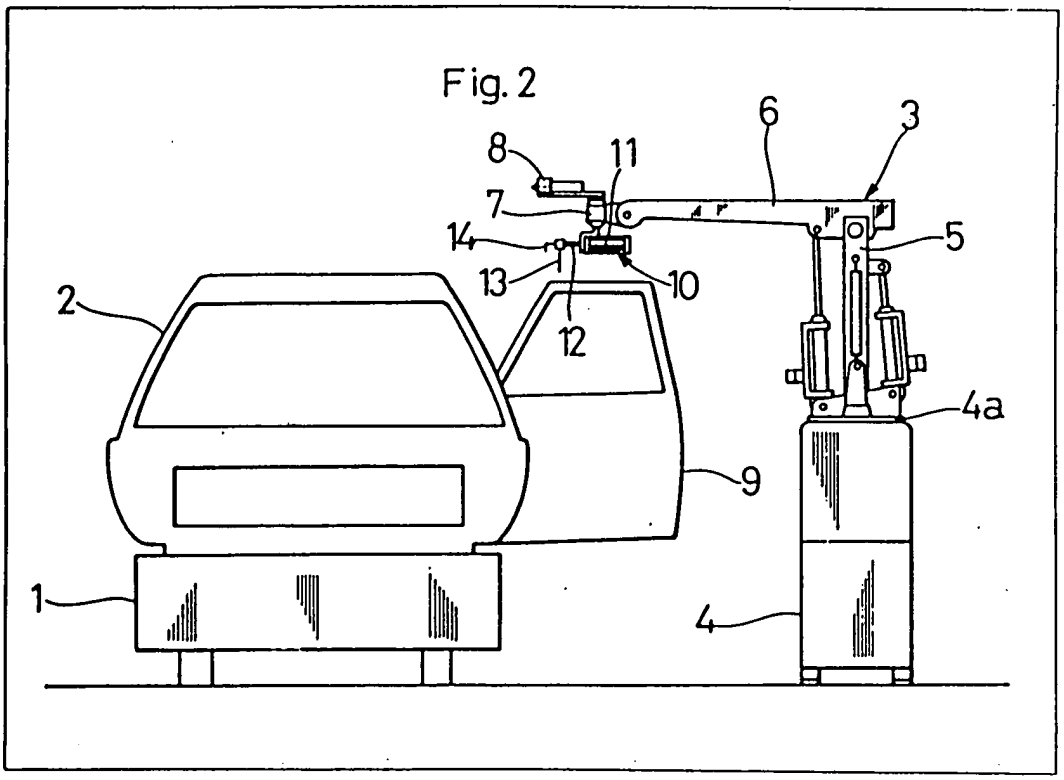
(54) Vehicle painting robot

(57) Robot for spray painting vehicle bodies (2) includes a device (10), associated with the spray applicator (8), for opening and closing the door (9) of the vehicle body. The device (10) comprises a finger (13) which engages the window raising door groove or a ring (22) [Fig. 5] therein. In alternative arrangement [Fig. 6] the door is engaged by a saw-tooth member (33). Fine adjustment of the position of the finger (13) or member (33) is achieved by a piston and cylinder unit (11).

Fig. 2



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SPECIFICATION
Robot

This invention relates to robots. More particularly it is concerned with an improved robot for applying paint or like coating on to a vehicle body.

The painting of the bodies of motor vehicles on a production line is becoming increasingly automated. Paint spraying robots are now available which are capable of painting even the interior surfaces of vehicle bodies as well as relatively inaccessible peripheral side portions of the vehicle doors, for example.

However, this requires that the doors of the vehicle body are opened before the inner side of the vehicle body and peripheral portions of the doors are painted, and thereafter closed. Conventionally it has been the practice for these operations to be performed by manual labour.

In an effort to avoid the need for employing workers just to open and close the doors, and so failing to achieve the full benefits which follow from automation, it has been suggested to employ robots designed specifically and exclusively for performing the opening and closing operations on the doors.

The present invention represents a significant departure from both these prior proposals and enables the painting or coating operation to be completely automated without resulting in apparatus of unnecessarily great size and of unnecessarily complicated construction.

In accordance with the present invention, there is provided a robot for applying paint or like coating on to a vehicle body, comprising: an arm supported on or from a pedestal such that its distal end may be rotated in both horizontal and vertical planes; a paint applicator supported on said arm for spraying paint or like coating toward said vehicle body; and a door handler mounted on said arm and engageable with the door of said vehicle body for opening and/or closing said door.

The invention is hereinafter more particularly described by way of example only, with reference to the accompanying drawings, in which:—

Fig. 1 is a schematic view of a vehicle body painting robot constructed according to the present invention in use;

Fig. 2 is a view of the robot of Fig. 1 in a different orientation and as seen in the direction of travel of vehicle bodies along the line;

Fig. 3 is a plan view of the robot of Figs. 1 and 2 in operation;

Fig. 4 is an enlarged fragmentary view for explaining the operation of the door handler of the robot of Figs. 1 to 3;

Fig. 5 is a view generally similar to Fig. 4 of an alternative embodiment;

Fig. 6 is a view generally similar to Figs. 4 and 5 of a further embodiment also in accordance with the present invention;

Fig. 7 is an enlarged fragmentary view showing certain components of a preferred embodiment of robot in accordance with the present invention;

Fig. 8 is an elevational view as seen from the left in Fig. 7;

Fig. 9 is a plan view of the apparatus of Figs. 7 and 8;

Fig. 10 is an enlarged fragmentary sectional view taken along the line X—X of Fig. 9

Figs. 1 to 3 show an embodiment of vehicle body painting robot 3 according to the present invention and a vehicle body 2 which has been delivered from an assembly line, to a paint coating station along a conveyor line by operation of a conveyor 1. The vehicle body painting robot 3 is located in a coating booth at a position close to the conveyor line. The coating robot 3 is either fixed on the floor or mounted on a carriage which is movable along the conveyor line. For convenience the robot 3 is here shown fixed but it may of course be replaced by a movable type.

The coating robot 3 is provided with a turn-table 4*a* on a pedestal 4. A first arm 5 is mounted on the turn-table 4*a* to be rotatable both in horizontal and vertical planes. Attached to the distal end of the first arm 5 is a second arm 6 which is rotatable in a vertical plane relative to arm 5. Supported at the distal end of the second arm 6 is a rotary actuator 7 which in turn supports on its output shaft, for rotation about the axis thereof, a paint applicator 8 for spraying paint or like coating toward the vehicle body. The chain line in Fig. 3 shows a typical range of operation for paint applicator 8 by operating the first and second arms 5 and 6. The paint spraying nozzle of the paint applicator 8 may be directed toward the vehicle body in a selected orientation irrespective of the positions of the first and second arms 5 and 6.

It is necessary to open vehicle door 9 prior to painting the inner side of the vehicle body and the peripheral portions of the door 9. Furthermore, the door has to be closed upon completion of the painting operation so that the vehicle may be transferred to the next work station in a closed state. In order to open and close the vehicle door 9, the rotary actuator 7 is provided with a door handler 10 which, as shown particularly in Fig. 4, includes a piston-cylinder 11 fixedly supported on the output shaft of the rotary actuator 7, a piston rod member 12 mounted for reciprocation relative to the piston-cylinder 11, a thrust finger 13 secured to the rod 12 at a position intermediate its ends, and a stop member 14 fixed to the distal end of the rod 12 to delimit the thrusting depth and position of the finger 13. For opening and closing the door 9, the first and second arms 5 and 6 are driven to position the door handler 10 over the door 9, and the finger 13 is thrust into a window raising groove 9*a* of the door 9, and the first and second arms 5 and 6 are then operated to pull or to push the door 9. The finger 13 is inserted into the window raising groove 9*a* as described to avoid the door handler 10 contacting and thus possibly damaging the coated paint film on the door 9 which is still in a wet state when the door is closed immediately after the coating operation.

The described painting robot 3 is enabled automatically to open and close the vehicle door if necessary while the vehicle body 2 is transferred through the coating booth by the conveyor 1. To achieve this, a programming or teaching operation is performed using the robot, the operations of the robot, including the sequence of actions necessary for opening and closing the door and for performing the painting operation being stored in a memory device (not shown). The operations of opening and closing the door and of painting are performed in practice by playing back the memorized sequence of actions as pre-programmed.

As soon as the conveyor 1 delivers a vehicle body 2 into the coating booth with the vehicle door 9 in closed state, the robot 3 is actuated to displace the first and second arms 5 and 6 in synchronism with the transfer speed of the vehicle body 2, locating the finger 13 of the door handler 10 immediately above the window raising groove 9*a*. Fine adjustment of the position of the thrust finger 13 is possible through operation of the piston-cylinder 11 of the door handler 10. The door handler 10 is lowered to thrust the finger 13 into the window raising groove 9*a*, and the door 9 is opened by applying a pulling force to the door handler 10. Since at the coating stage the door lock will not as yet be mounted on the door 9, the door can be opened or closed by application of only slight pulling or pushing force.

As soon as the door 9 is opened, the finger 13 is disengaged from the window raising groove 9*a*, and the paint applicator 8 is actuated to spray paint or like coating over the vehicle body 2. The paint is readily coated on the inner side of the vehicle body and around the edges of the door 9 and door opening since the door is in its opened state.

After coating the vehicle body 2 in the above described manner, the door handler 10 is actuated again, thrusting the finger 13 into the window raising groove 9*a* and pushing the door 9 into its closed position to complete the coating operation. The coated vehicle body 2 is passed forward to the next work station in the conveyor line.

Vehicle body painting robots in accordance with the present invention may be adapted for use where the vehicle body 2 is delivered to the coating booth with the door 9 in an opened state. In such a case, the paint coating operation is started immediately on arrival of the vehicle body 2, and the vehicle door 9 is closed after finishing the coating operation by operating the door handler 10 as described hereinabove.

Figures 5 and 6 show parts of two alternative embodiments of painting robots also in accordance with the present invention. In the second embodiment of Fig. 5, an attachment 22 with a ring 22*a* is fitted in a window raising groove 21*a* of a vehicle door 21 for co-operation with a door handler 26 which along with a paint applicator 25 is connected to a rotary actuator 24 at the distal end of second arm 23 (which corresponds to second arm 6 of the embodiment of Figs. 1 to 3). The door handler 26 includes a piston-cylinder 27 with a reciprocable piston rod which is bent downward to form a finger 28. The door 21 is opened or closed by inserting the finger 28 into the ring 22*a* followed by contraction or extension of the piston-cylinder 27.

In the third embodiment of Fig. 6, the door handler 31 is constituted by a piston-cylinder 32 and a saw-tooth-like member 33 which is mounted for reciprocation relative to the piston-cylinder on its piston rod 32. Saw-tooth-like member 32 makes frictional engagement with the edge of vehicle door 34 in the region of a window raising groove 34*a* to open and close the door 34.

Figures 7 to 10 illustrate a fourth and preferred embodiment of painting robot in accordance with the present invention, in which a rotary actuator 42 is mounted at the distal end of a second arm 41 of the painting robot (corresponding to arm 6 of the embodiment of Figs. 1 to 3). The output shaft 42*a* of the rotary actuator 42 has a support plate 43 fixed thereto for supporting a paint applicator 44 fixedly thereon. A door handler 45 is mounted beneath the support plate 43. The door handler 45 includes a substantially U-shaped bracket 46 which is secured to the lower side of the support plate 43, a shaft 47 which is mounted on the bracket 46, a finger 48 which is rotatably supported on the shaft 47, and a spring 49 which biases the finger 48 into abutting engagement with the rear of bracket 46 (that is: to the position shown in solid lines in Fig. 7). A reinforcing plate 43*a* provided beneath the support plate 43 interconnects shaft 42*a* and bracket 46. The vehicle door 50 is opened or closed by inserting the finger 48 in the window raising groove 50*a* of the door 50. Should the finger 48 abut against the upper side of the door 50 without engaging in the window raising groove 50*a*, it will rotate about shaft 47 against the biasing action of the spring 49 as indicated in phantom in Fig. 7. Upon raising the door handler 45, the finger 48 will return to its initial position by the action of the spring 49.

Should a vehicle body be delivered to the paint station in a position or orientation which deviates from the norm or with the door 50 in a half-open state, it becomes difficult to insert the finger 48 correctly in the window raising groove 50*a*. To overcome this problem in this embodiment, a sensor 51 is provided on the support member 43 along with the door handler 45 to detect the position of the window raising groove 50*a* of the door 50. Both sensor 51 and door handler 45 extend normal to a plane including the axis of the second arm 41. The sensor 51 consists, for example, of an ultrasonic wave generator 52 and a receiver 53 as shown in Fig. 10. The ultrasonic wave generator 52 and receiver 53 are mounted on a base plate 55 within a housing 54 which is fixedly provided on the support plate 43. The ultrasonic waves pass through an aperture 56 in the base plate 55 and advances toward the door 50 through opening 54*a* at the lower end of the housing 54. Ultrasonic waves reflected on the bottom surface of the window raising groove 50*a*

will be received by the receiver 53 through an aperture 57 in the base plate 55, so that the position of the window raising groove 50*a* can be detected by measuring the time lapse from generation to reception of transmitted ultrasonic waves. The above-mentioned ultrasonic sensor 51 may be replaced by an optical sensor if desired.

If the sensor 51 is located close to the paint applicator 44 as shown, it may receive some of the spray of paint. Paint may deposit on the generator 52 and receiver 53, lowering the efficiency of detecting the position of the window raising groove 50*a* by the sensor 51. To avoid this, we employ an air feed pipe 58 connected to the housing 54 for supply of purging air. The air feed pipe 58 blows air into the housing 54 and through the opening 54*a* at its lower end to prevent paint from entering the housing 54.

With the above-described preferred construction, the finger 48 of the door handler may be securely received in the window biasing groove 50*a* even though the position or orientation of a delivered vehicle body may deviate from the norm or the vehicle door 50 may be in a half-open state.

CLAIMS

1. A robot for applying paint or like coating on to a vehicle body, comprising: an arm supported on or from a pedestal such that its distal end may be rotated in both horizontal and vertical planes; a paint applicator supported on said arm for spraying paint or like coating toward said vehicle body; and a door handler mounted on said arm and engageable with the door of said vehicle body for opening and/or closing said door.

2. A robot according to Claim 1, wherein said door handler is provided with a finger member adapted to be received in a window raising groove of said door.

3. A robot according to Claim 2, wherein said finger member is coupled to a piston-cylinder for linear reciprocation.

4. A robot according to Claim 2, wherein said finger member is displaceably supported on a bracket.

5. A robot according to any of Claims 2 to 4, wherein said door handler is provided with a sensor for detecting the position of said window raising groove.

6. A robot according to Claim 5, wherein said sensor is of a non-contact type.

7. A robot according to Claim 6, wherein said sensor is an ultrasonic sensor.

8. A robot according to Claims 6 or 7, wherein said sensor is connected to an air feed pipe for receiving a supply of purging air whereby to prevent deposition of sprayed paint on sensing portions of said sensor.

9. A robot according to Claim 1, wherein said door handler is provided with a finger member adapted to be inserted in a ring which is formed on an attachment fitted in a window raising groove of said door.

10. A robot according to Claim 1, wherein said door handler is provided with a saw-tooth-like member for frictional engagement with said door.

11. For applying paint or like coating on to a vehicle body, a robot substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

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Fig. 1

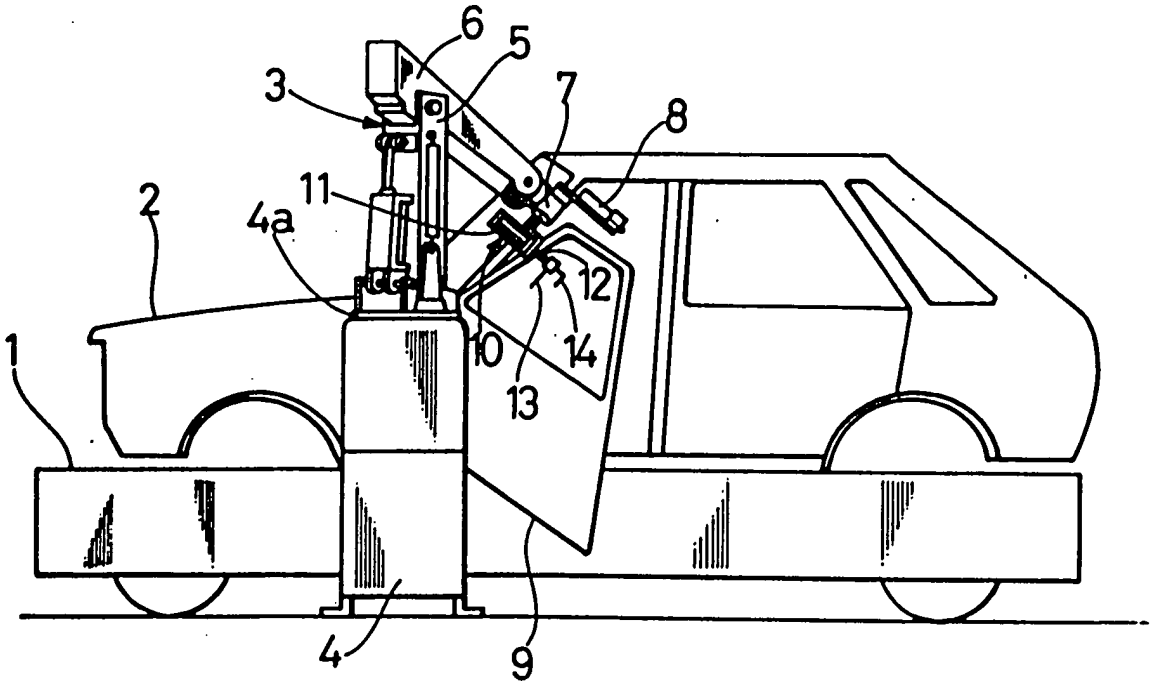

Fig. 2

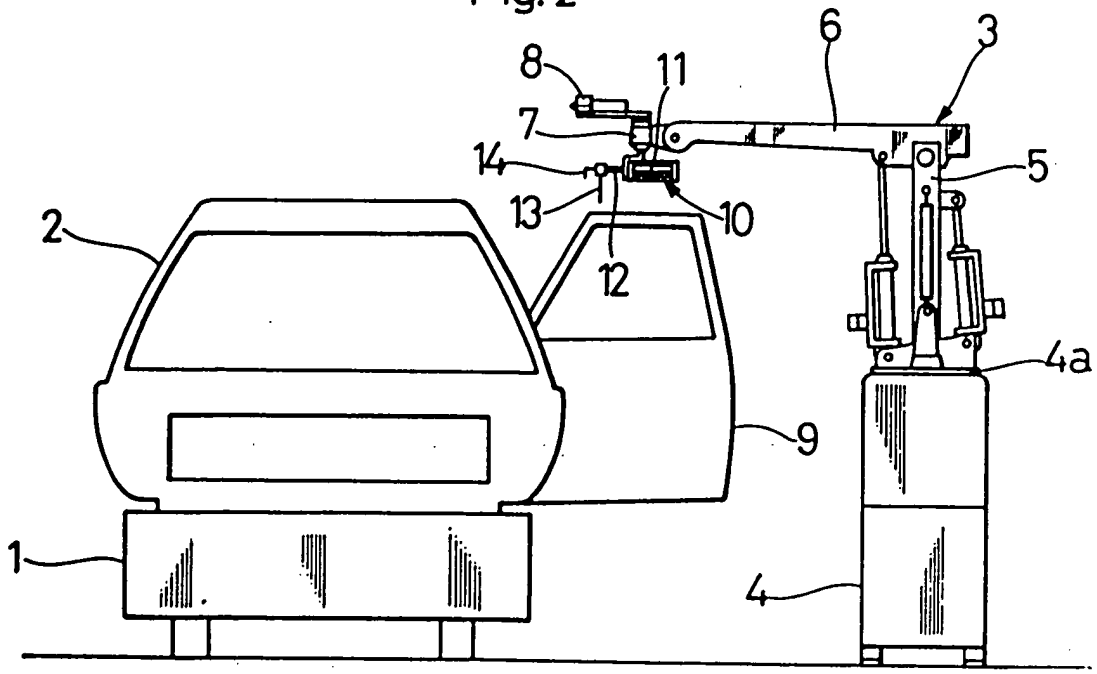

Fig. 3

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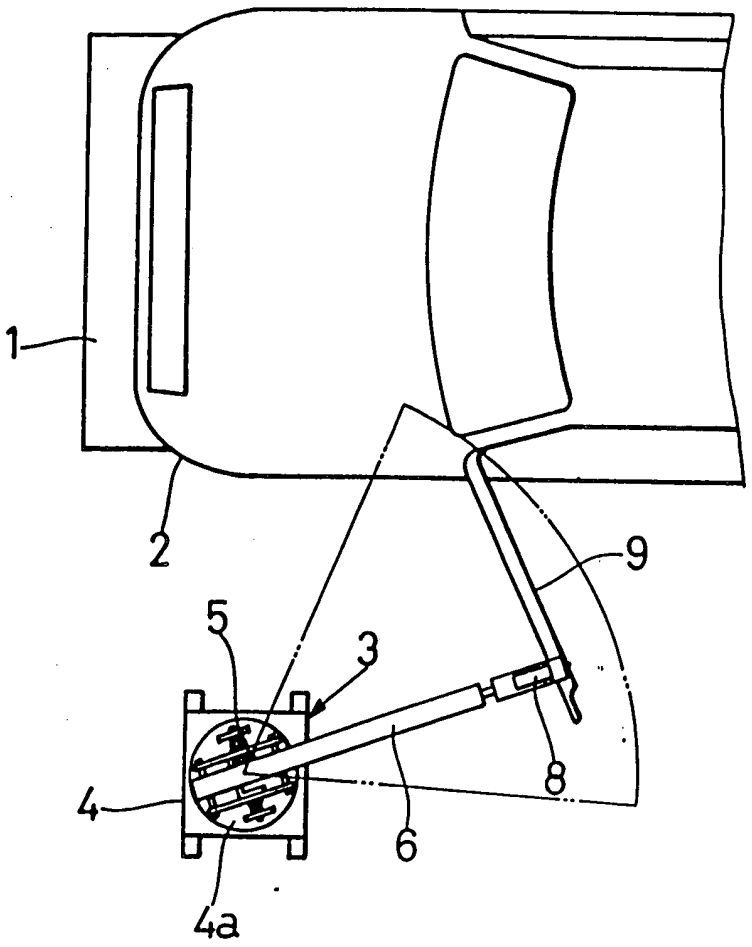

Fig. 4

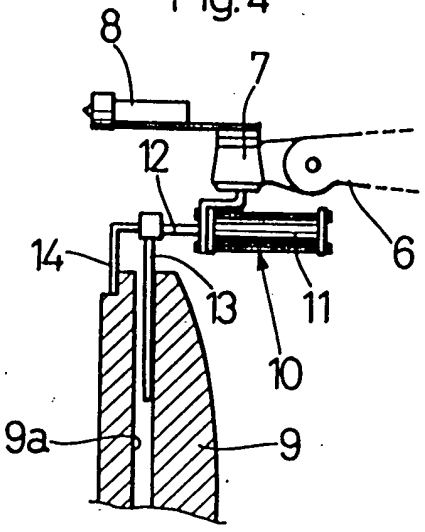

Fig.5

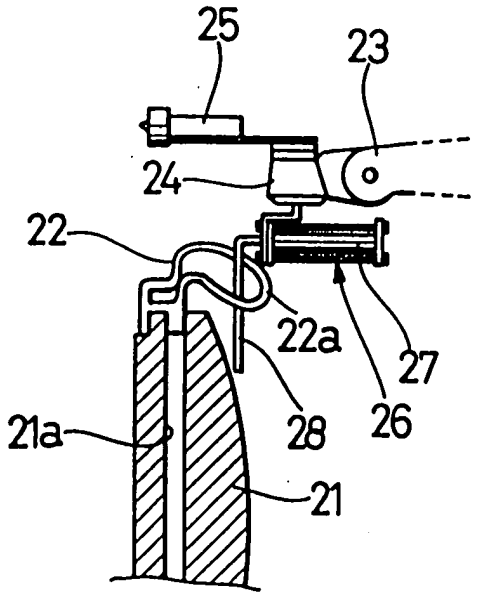

Fig.6

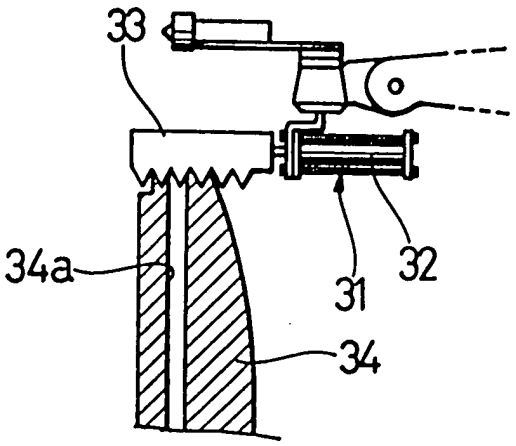

Fig. 7

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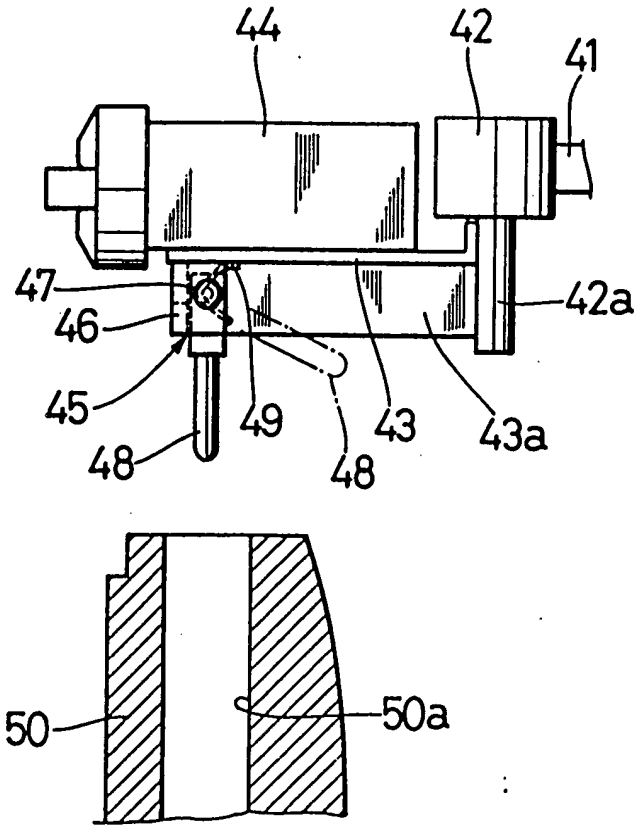


Fig. 8

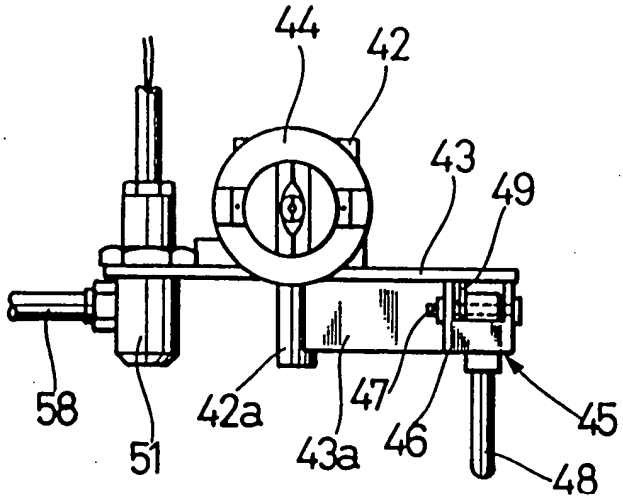


Fig. 9

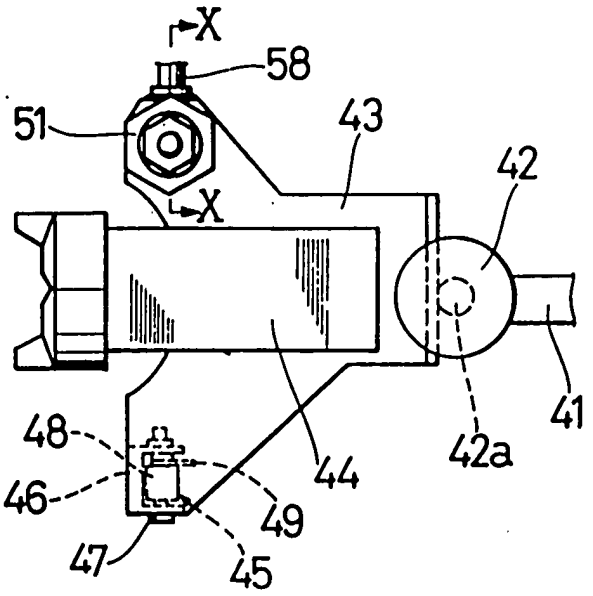
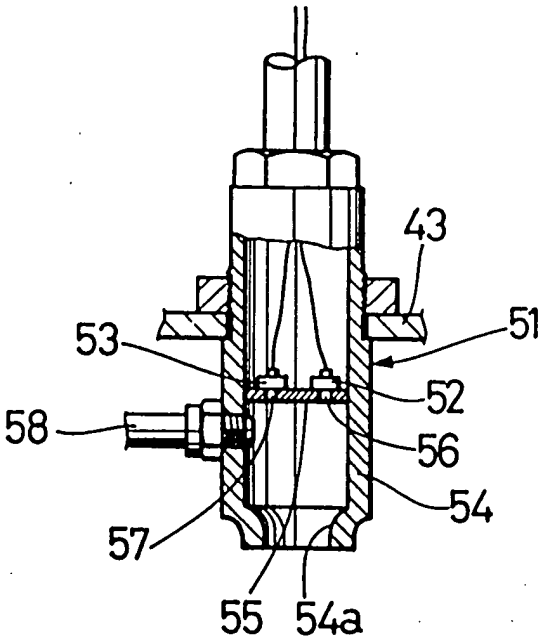


Fig. 10



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